A Mobile Solution for Linguistic Communication with Deaf-Blind People Using Arduino and Android

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***Abstract*— Nowadays technology has been used for numerous purposes and it is still possible to find applications and solutions not explored before that could bring benefits to part of the population that has not received attention from many researches yet. This paper aims to present the main needs of deaf-blind people, their demands and a proposal of a mobile solution to facilitate and expand interpersonal communication with deaf-blind people, including those people who do not have familiarity with the methods of communicating with deaf-blind people by specific sign language.**

***Keywords*— Deaf-blind, Multi-sensory disabilities, Interface, Arduino, Android.**

I. INTRODUCTION

Multisensory disabled people are people with visual impairment and hearing impairment, associated with other conditions, whether in the field of physical, mental or emotional and learning subjects. [1].

As children, for instance, they demonstrate serious difficulties such as difficulty understanding routines of day-to-day gestures or other forms of communication, of course, also demonstrating difficulty recognizing people who are around them. There is little response to sound, movement, touch and other stimulation.

The complexity in anticipating events or what is happening around them makes each new experience looks like something scary, like simple actions as going from one place to another or even eating or touching food. In addition, their interest in recognizing the environment is decreased due to these physical and psychological barriers which they have to deal with. They actually should be encouraged to create their communication and recognition method to compensate their visual and hearing impairment, and to develop the creation and maintaining of interpersonal relationships.

II. THE DEAFBLINDNESS

Among people with multi-sensory disabilities are the deaf-blind people. According to the Decalogue of the deaf-blind, a declaration adopted at the Fourth "Helen Keller" World Conference, held in 1989 in Stockholm, "deafblindness is a single disability rather than the simple sum of the deafness disability and blindness disability, requiring specialized services." Miles and Riggio [8] classify deaf-blind people as:

- profoundly deaf and blind people
- deaf people with low vision;
- people with low hearing and who are blind;
- people with low vision and poor hearing.

These multi-sensory disabilities can be obtained congenitally or acquired, "congenital when the individual is born with this unique disability; acquired when the individual is born listener, seer, deaf or blind, and because of different biological or external factors, acquires deaf-blindness" [3]. Its causes are associated with many situations but mainly "due to congenital rubella, meningitis and Usher Syndrome" [3]. Regardless of whether congenital or acquired, the study and creation of communication methodology is needed to facilitate the interaction of these people with the society, allowing them to decrease their difficulty in socialization, following the Decalogue of the deaf-blind [12], which states that "Communication is the biggest barrier to personal development and education of the deaf-blind, therefore the teaching of effective communication methods should be prioritized."

Nowadays, deaf-blind people still need the support of a guide and they also need those guides to interpret signals and to communicate with people for them. This dependence can decrease the socialization ability and conversational possibilities with those who can't communicate using specific sign language for deaf-blind people, as well as the dependence of the interpreter that is not always available to people with this disability.

Ampudia [2] says that the great difficulty deaf-blind children have is precisely in developing a learning mode to compensate the visual and hearing handicap and allow the relationship with the world. So, it is essential to explore the potential of remaining senses (touch, taste and smell) for orientation and perception, which justifies furthermore the possibility of using technologies that leverage the remaining senses and offer the individual some communication independence and socialization with others. Therefore, it is necessary to look for tools that can assist them in communicating due to the fact that there is a weakness in the very essential senses that enables the communication process.

III. TECHNOLOGY AS AN AID TO COMMUNICATION

Nowadays, it is noticeable the growth in technology usage by society, including creating a dependent relationship with these technological resources that facilitates the daily lives of human beings. A topic that has been a research focus in many countries is the Internet of Things, where not only men interact with machines, but also where objects communicate with themselves through the Internet. "The internet of things will revolutionize our daily life, turning tasks that today are complicated in simpler tasks, thanks to the use of micro-controllers that will assist in various areas ranging from industrial automation to the field of medicine, for example. Cities will become increasingly intelligent thanks to this technology, and communication between the government and people will be facilitated, even environmental disasters can be avoided thanks to the use of this new technology. "[10].

Arduino plays an important role in this whole process. It is one of the main instruments nowadays to the study and development of technologies that will be used in the Internet of Things, and which has allowed the improvement of various areas of society, regardless of social and financial class, always focusing on supply or optimize human needs.

Conceived in 2005 by Massimo Banzi, Arduino, which is an "Open Source Hardware", is based on a microcontroller that is easy to use and program, initially created to facilitate the teaching of electronics, but because of its simplicity , it has been used in schools for teaching to children, adults and researchers, inspiring many people around the world to develop ideas that used to be impossible without having a great knowledge in electronics, "aiming to encourage this open innovation, creating an aura around the technology that helps to sell it, cutting radically development costs and allowing projects that are always one step ahead, thanks to the skills and dedication of thousands of specialists all over the world "[11].

IV. THE DEAF-BLIND INTERFACE DEVELOPMENT

Due to the motivation presented by this paper, and to contact with a philanthropic and non-profit civil organization specialized in caring for people with multiple disabilities, we have identified the possibility of developing a device that could help this institution and their patients in teaching and in linguistic communication with deaf and blind people, just using the enhancement of the touch sense, creating possibilities for communication with any individual using Morse code, originally created for use in telegraphs, "where each letter of the alphabet and each number has a sequence of dots and dashes (long and short pulses), with a stroke 3 times longer than a period "[4], in order to use this communication standard using the vibration technology as a means of reception of a signal by the disabled person.

Using an Arduino microcontroller connected to a vibrating micro-engine (as used in smartphones that has vibrating mode), command buttons, and a Bluetooth HC-06 Module, often used with Arduino, we started the development of a prototype, respecting hardware limitations, but creating an interface that could somehow send and receive messages via Bluetooth, so that at the end of the translation to the device, the disabled person could "read" the message using the vibration of Morse code.

We decided to use the Bluetooth communication because in addition to low power consumption and its easy configuration when used with the Arduino board, it also can be directly paired to another interface without additional parameterization, which does not occur with a wireless module 802.11 where routers and their wireless networks need to be set up directly via Arduino programming, which would not allow flexibility in use of the device by the disabled, for example, for entering an authentication password for a specific SSID.

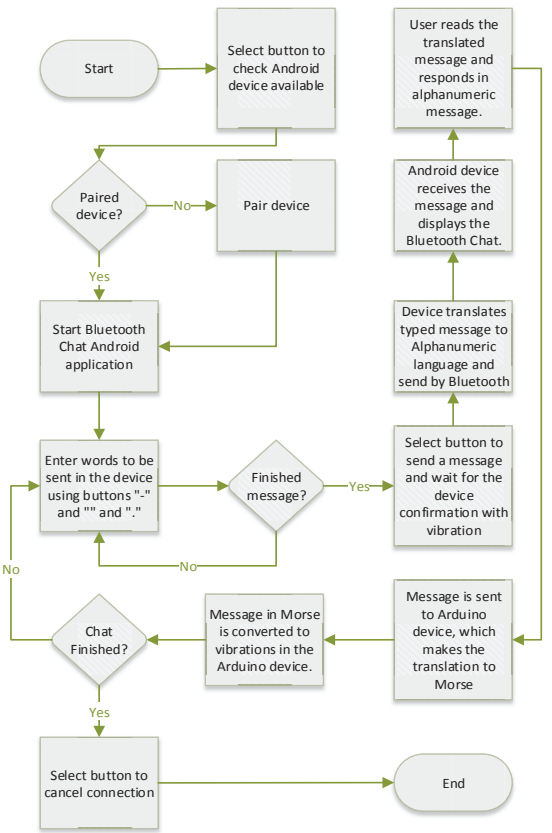

Figure 1. Diagram demonstrating the operation of the interface

In addition to these components, since the goal of the device is to provide mobility, the final prototype will have a rechargeable battery, so that it works without the need to be plugged into any outlet.

Thinking about the usability and practicality of the device as well as its portability, it would have the following buttons:

- Button 1: Connect
- Button 2: "." Morse code for dot

- Button 3: "_" Morse code for dash
- Button 4: "ok" - a confirmation used to complete a letter, a word or a phrase, sending the message, having the following functions:
  - 1 click (end of letter)
  - 2 clicks (end of the word)
  - 3 clicks (end of sentence)
- Button 5: "Cancel or Search Bluetooth devices" having the following functions:
  - 1 click (search)
  - 2 clicks (cancel connection to all devices).

In order to include the whole process of data transmission and reception on the interface created using Arduino, the prototype will be responsible for receiving the text sent through the application, to be presented in the following paragraphs, as well, as the translation of the text received in Morse code, and vice versa, in order to convert all text vibrations, or converting the Morse code into intelligible text to others.

This process can be seen in the Table 1, which shows a small code of Arduino programming [5] [6], specifically the process of typing a message in Morse and his conversion on the device with Arduino.

TABLE I. ARDUINO SOURCE CODE FOR MORSE TRANSLATION IN THE PROTOTYPE

```
void loop()
{
// Character Array
char letters[36] =
{'A','B','C','D','E','F','G','H','I','J','K','L','M'
,'N','O','P','Q','R','S','T','U','V','W','X','Y','Z'
,'0','1','2','3','4','5','6','7','8','9'};
// Morse Array
char ditdit[36][36]= {{'.','-'},{'-
','.','.','.'},{'-','.','-','.'},{'-
','.','.'},{'.'},{'.','.','-','.'},{'-','-
','.'},{'.','.','.','.'},{'.','.'},{'.','-','-','-
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'},{'.','.','-','-','-'},{'.','.','.','-','-
'},{'.','.','.','.','-'},{'.','.','.','.','.'},{'-
','.','.','.','.'},{'-','-','.','.','.'},{'-','-','-
','.','.'},{'-','-','-','-','.'}};
char message[] = ""; // Array that stores the whole
message.
char palavra[]= ""; // Array that stores each word.
noTone(Buzz); // Interrupts vibration

// Reading the Arduino device
  while (!digitalRead(BTEsp)){
// While the BHTEsp is not tight, the array will be
mounted morse
  if(digitalRead(BTTrac))
// When BTrac tight, insert the character _ in the
message array.
  {
    strcat(message,"-");
    Serial.println(message);
// displays the contents of the message array
// Does the vibrate over _ the morse for the user to
identify the tight Button
    tone(Buzz,1500);
    delay(750);
    noTone(Buzz);
  }

  else if(digitalRead(BTPont)) // When BTPont tight,
insert the character   in the message array.
  {
    strcat(message,".");
    Serial.println(message);

// Does the beep / vibrate short of "." Morse  for
the user to identify the tight Button
    tone(Buzz,1500);
    delay(250);
    noTone(Buzz);
 }
```

V. PROTOTYPE FOR LINGUISTIC COMMUNICATION WITH SMARTPHONES

Based on the features offered by the prototype and on the possibility of bluetooth´s module usage in full-duplex communication (sending and receiving data), the continuity of the project could be the pursuit of developing an application for smartphones.

This application is necessary to allow smartphone users who do not have disabilities neither know methods of communicating with deaf-blind nor the use of Morse code can, via a mobile device, type a message in the application and the same can be sent to the interface created, which will convert the text into Morse code, and then immediately it turns into vibrations to the deaf-blind person.

This application allows a range of communication possibilities with deaf-blind people. It respects the Decalogue of the Deaf-Blind previously mentioned: the possibility of communication of a deaf-blind to any individual who has a mobile phone could break a big barrier existent today and would limit the disabled communication only with a small number of people.

For application development, initially we choose mobile devices using Android as operating system. According to IDC Institute [7], is responsible for 82.8% of smartphones sold today in the world market, which can be seen in Figure 2.

Period	Android	iOS	Windows Phone
2015Q2	82.8%	13.9%	2.6%
2014Q2	84.8%	11.6%	2.5%
2013Q2	79.8%	12.9%	3.4%
2012Q2	69.3%	16.6%	3.1%

Figure 2. Smartphone OS Market Share. IDC, Aug 2015

After choosing the operating system for starting the application development, a research led to the project *BluetoothChat* source code, available on GitHub website [9], a code example available to demonstrate the use of Bluetooth Android API that can be run by two Android devices at the same time, to establish chat over Bluetooth between these devices, among the already available functions, also allows to:

- Set up Bluetooth;
- Search for other Bluetooth devices;
- Pair the local Bluetooth adapter to another device;
- Transfer data among the devices.

Based on this code, some changes were made. Among them, we changed the application source code to allow it to be compatible not only with Android devices, but also with Bluetooth interface HC-06, used in the Arduino, responsible for interpreting and the conversion for Morse code messages.

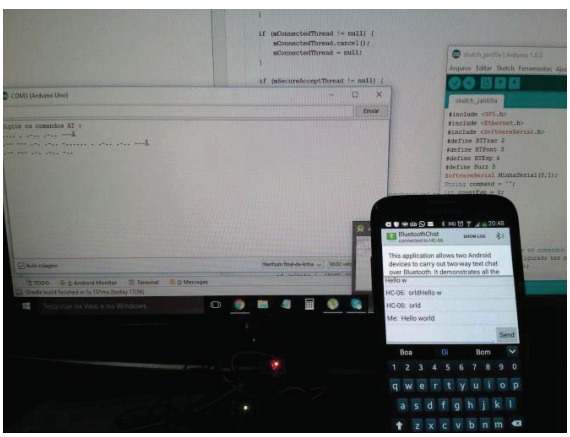

Figure 3. Running tests with BluetoothChat and Arduino

We have performed tests and confirmed the feasibility of the project. The application and prototype will be tested in the partner institution in order to identify potential improvements, as well as to allow future implementations, as planned, in the final version.

VI. FUTURE IMPLEMENTATIONS

Given that in the current phase of the project we decided to focus on the implementation of the application and its interaction with the deaf-blind interface, new implementations were inserted in it at a later stage, but that we can not fail to mention due to the usefulness of these resources.

For the final step in the implementation of the project we will include:

- Changes in the Application interface, improving the usability to the end user of the Android device
- Ultrasonic sensor: for the use of the interface to detect objects and obstacles near the deaf-blind to keep their safety and avoid accidents. The sensor use the same mechanisms of the parking sensor used in today's cars.
- LED and Buzzer: For the use by deaf-blind people that can still see, although through a limited vision, or hear, in a limited way.

CONCLUSION

This paper is the result of the researches made by a scientific initiation group that studies and researches automation possibilities using Arduino at the University Center Estácio Juiz de Fora. During the research and focusing on projects that can help people with difficulties and shortcomings, it is clear that there is a range of possibilities where the *Internet of Things* have not been targeted.

It is necessary that researchers identify ways that benefit these disabled people and that can benefit from small solutions but that make a big difference in theirs lives. This proposal, created using inexpensive resources as Arduino and other devices and the Android app, allows the facilitation of the socialization of these disabled people and will certainly make a difference in their lives.

However, this first prototype is not intended for commercial use. The main goal is to help the institute where we identified the initial demand. Even so this solution can be easily implemented in any other institutions and could be an initiative that can motivate the creation of new solutions for the multisensory disabled people.

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